SYNTHESIS AND SINTERING OF PZT CERAMICS

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ABSTRACT

Lead zirconate powder, with Zr/Ti ratio of 50/50 was prepared by polymeric precursor method and doped with 3, 5 and 7 mol% of Sr^{+2} or Ba^{+2}, as well as by 0.2 to 5 mol% of Nb^{+5}. The powder was calcined at 750°C by 4 hours and milled during 1.5 h in isopropilic alcohol. Powders were characterized by surface area measurements (BET method), by infrared spectroscopy and by X-ray diffraction to characterize the crystal structure. Isostatically pressed samples were sintered in a dilatometer furnace by using a constant heating rate of 10 °C/min from ambient to 1200°C. Synthetic air and air with water vapor were used as atmospheres. Both Sr^{+2} and Ba^{+2} substitute Pb^{+2} and favor the formation of rhombohedral phase. Otherwise, Nb^{+5} substitute preferentially Zr^{+4} favoring tetragonal phase. The concentration of dopants and the atmosphere influence the densification and the microstructure of the PZT, which alters the dielectric and piezoelectric properties of the ceramics.

INTRODUCTION

Lead Zirconate Titanate (PZT) is a ferroelectric ceramic, largely used as a piezoelectric material in sensor and actuator applications[1-3] because of its large electromechanical coupling coefficients, temperature stability, and high resistance to depolarization. In lead zirconate titanate (PZT) preparation, the control of some parameters is important to achieve the desired material properties. These parameters include the absence of intermediate crystalline phases, a defined and fixed stoichiometry, as well as a homogeneous lead distribution in the microstructure. In conventional processing[4,5] PZT are prepared by mixture and calcining PbO, ZrO_2 and TiO_2 powders. This process requires high sintering temperature and causes the PbO loss. In recent years sol-gel processing[6-9] and co-precipitation[10] has becoming popular for producing ceramic materials with improved compositional homogeneity and lower sintering temperatures. However, the sol-gel process

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and advanced ceramics Topics covered in the area of advanced ceramic include bioceramics nanomaterials composites solid oxide fuel cells mechanical properties and structural design advanced ceramic coatings ceramic armor porous ceramics and more *Advances in Cement Technology* S.N. Ghosh,2003-01-01 This volume is the outcome of a critical review of the most important and useful aspects of science and technology of cement The contents present a combination of cement chemistry including mathematical modelling manufacture showing geology of limestone and other raw materials concrete and other blends instrumental analysis showing thermoanalytical techniques and x rays This publication should be of specific interest to students and researchers material scientists cement chemists and technical personnel and engineers in cement and concrete industry and laboratories **Comprehensive Hard Materials** Daniele Mari,Luis Miguel,Christoph E. Nebel,2014-02-01 Comprehensive Hard Materials Three Volume Set deals with the production uses and properties of the carbides nitrides and borides of these metals and those of titanium as well as tools of ceramics the superhard boron nitrides and diamond and related compounds Articles include the technologies of powder production including their precursor materials milling granulation cold and hot compaction sintering hot isostatic pressing hot pressing injection moulding as well as on the coating technologies for refractory metals hard metals and hard materials The characterization testing quality assurance and applications are also covered Comprehensive Hard Materials provides meaningful insights on materials at the leading edge of technology It aids continued research and development of these materials and as such it is a critical information resource to academics and industry professionals facing the technological challenges of the future Hard materials operate at the leading edge of technology and continued research and development of such materials is critical to meet the technological challenges of the future Users of this work can improve their knowledge of basic principles and gain a better understanding of process structure property relationships With the convergence of nanotechnology coating techniques and functionally graded materials to the cognitive science of cemented carbides cermets advanced ceramics super hard materials and composites it is evident that the full potential of this class of materials is far from exhausted This work unites these important areas of research and will provide useful insights to users through its extensive cross referencing and thematic presentation To link academic to industrial usage of hard materials and vice versa this work deals with the production uses and properties of the carbides nitrides and borides of these metals and those of titanium as well as tools of ceramics the superhard boron nitrides and diamond and related compounds *High Value Manufacturing: Advanced Research in Virtual and Rapid Prototyping* Paulo Jorge da Silva Bartolo,Ana Cristina Soares de Lemos,Antonio Mario Henriques Pereira,Artur Jorge Dos Santos Mateus,Catarina Ramos,Cyril Dos Santos,David Oliveira,Elodie Pinto,Flavio Craveiro,Helena Maria Coelho da Rocha Terreiro Galha Bartolo,Henrique de Amorim Almeida,Ines Sousa,Joao Manuel Matias,Lina Durao,Miguel Gaspar,Nuno Manuel Fernandes Alves,Pedro Carreira,Telma Ferreira,Tiago Marques,2013-09-16 High Value Manufacturing is the result of the 6th International Conference on Advanced Research in Virtual and Rapid

Prototyping held in Leiria Portugal October 2013 It contains current contributions to the fi eld of virtual and rapid prototyping V RP and is also focused on promoting better links between industry and academia This volume comprises a collection of more than 110 reviewed papers which cover a wide range of topics such as Additive and Nano Manufacturing Technologies Biomanufacturing Materials Rapid Tooling and Manufacturing CAD and 3D Data Acquisition Technologies Simulation and Virtual Environments and novel applications High Value Manufacturing is intended for engineers designers and manufacturers who are active in the fi elds of mechanical industrial and biomedical engineering Apatites and their Synthetic Analogues Petr Ptáček,2016-04-13 Apatite type minerals and their synthetic analogues are of interest of many industrial branches and scientific disciplines including material sciences chemical industry agriculture geology medicine and dentistry This book provides a basic overview of general knowledges of this topic in order to provide the comprehensive survey from a scientific and technological perspective The book is divided into 10 chapters which are devoted to the structure and properties of minerals from the supergroup of apatite experimental techniques of preparation and characterization of synthetic analogues of apatite minerals substitution in the structure of apatite as well as utilization of these materials in wide range of common and special advanced applications in industry material sciences and research Additionally the phosphate rocks their classification geological role mining and beneficiation of phosphate ore production of elemental phosphorus phosphoric acid and fertilizers are also described Although this book is meant for chemist material scientist and research engineers the individual chapters contain theoretical background historical aspects as well as examples of synthetic and analytical methods which may be also interesting for students and non expert readers as well

Advanced Research on Material Science, Environment Science and Computer Science III Helen Zhang,David Jin,X.J. Zhao,2014-01-13 Selected peer reviewed papers from the 2014 3rd International Conference on Material Science Environment Science and Computer Science MSESCS 2014 January 11 12 2014 Wuhan China Advances in Ceramics Costas Sikalidis,2011-08-09 The current book contains twenty two chapters and is divided into three sections Section I consists of nine chapters which discuss synthesis through innovative as well as modified conventional techniques of certain advanced ceramics e g target materials high strength porous ceramics optical and thermo luminescent ceramics ceramic powders and fibers and their characterization using a combination of well known and advanced techniques Section II is also composed of nine chapters which are dealing with the aqueous processing of nitride ceramics the shape and size optimization of ceramic components through design methodologies and manufacturing technologies the sinterability and properties of ZnNb oxide ceramics the grinding optimization the redox behaviour of ceria based and related materials the alloy reinforcement by ceramic particles addition the sintering study through dihedral surface angle using AFM and the surface modification and properties induced by a laser beam in pressings of ceramic powders Section III includes four chapters which are dealing with the deposition of ceramic powders for oxide fuel cells preparation the perovskite type

ceramics for solid fuel cells the ceramics for laser applications and fabrication and the characterization and modeling of protonic ceramics **Department of the Interior and related agencies appropriations for 1990** United States. Congress. House. Committee on Appropriations. Subcommittee on Department of the Interior and Related Agencies,1989 *Department of the Interior and Related Agencies Appropriations for 1990: Justification of the budget estimates* United States. Congress. House. Committee on Appropriations. Subcommittee on Department of the Interior and Related Agencies,1989 **Scientific and Engineering Computations for the 21st Century - Methodologies and Applications** M. Mori,T. Mitsui,2002-12-03 The 20th century saw tremendous achievements and progress in science and technology Undoubtedly computers and computer related technologies acted as one of vital catalysts for accelerating this progress in the latter half of the century The contributions of mathematical sciences have been equally profound and the synergy between mathematics and computer science has played a key role in accelerating the progress of both fields as well as science and engineering Mathematical sciences will undoubtedly continue to play this vital role in this new century In particular mathematical modeling and numerical simulation will continue to be among the essential methodologies for solving massive and complex problems that arise in science engineering and manufacturing Underpinning this all from a sound theoretical perspective will be numerical algorithms In recognition of this observation this volume focuses on the following specific topics 1 Fundamental numerical algorithms 2 Applications of numerical algorithms 3 Emerging technologies The articles included in this issue by experts on advanced scientific and engineering computations from numerous countries elucidate state of the art achievements in these three topics from various angles and suggest the future directions Although we cannot hope to cover all the aspects in scientific and engineering computations we hope that the articles will interest inform and inspire members of the science and engineering community *Applied physics in Serbia-APS* ,2002 *Annual Report of Materials Science Laboratory (2014);Annual Report of Materials Science Laboratory (2015)* Miroslav Stanković,Jelena Majstorović,Branko Matović,Vesna Maksimović,Milena Rosić,Danica Dimitrijević,Jelena Zagorac,Marija Prekajski,Jovana Ružić,Jelena Zagorc,Dejan Zagorac,Aleksandra Zarubica,J. Christian Schön,Katarina Djuris,Ana Radosavljević-Mihajlović,Branka V. Kaluđerović,M. Srećković,S. Jevtić,Z. Latinović,Dj. Milanović,S. Ostojić,Maja Kokunešoski,Sleksandar Šaponjić,Mirjana Pavlović,Jelena Pantić,Snežana Nenadović,Ljiljana Kljajević,Miijana Mirković,Jelena Gulicovski,Ljiljana Živković,Katarina Trivunac,Bojan Šešlak,Ivana Vukanac,Vladimir Pavlović,M. Miljković,D. Poleti,M. Pošarac-Marković,Dj. Janaćković,Milan T. Jovanović,Višeslava Rajković,Ivana Cviović-Alagić,N.D. Nikolić,B. Jokić,Ksenija Kumrić,Gajić-Krstajić, M.,Lukić, M.,Marković, S.B.,Stojanović, Z.S.,Orlić, J.,Babić, M. ,Mitrović, S.,Pešić, M., A.,Podolski-Renić,Stojković, S.,Bogdanović, G., Kojić, V.,Bajuk-Bogdanović -Cvjetićanin, M.C.,Holclajtner-Antunović I.,N. Milenković,,Mentus S.,Mojović, M.,Pavićević, A.,Stojković, I. ,Vukelić N.S.,Baščarević, Z. ,Dimitrijević, M.,Elezović, N.R.,Kalauzi, A.,Lačnjevac, U.Č.,Milenković, I. ,Radotić, K.,Savić, A.,Simović, B.,Majstorović, J. ,Milošević, M.,Rosić,

A.,Vuković, N.,Vulić, P.,Aškrabić, S.,Z.D. -Kovačević A.G.,Dohčević-Mitrović ,Paunović, N.,Radović, M.,Todorović, B.,Bojić, A.L.,Bojić, D.V.,Mitrović, J.Z.,Petrović, M.M.,Ranđelović, M. ,Zarubica, A.,Grujić-Brojčin, M.,Matković, A.,Tomić, N.,Šćepanović, M.,Abramović, B. ,Finčur, N.,Banković, P.T.,Krstić, J.,Obradović, M.D.,2016-03-29 **Scientific Information Bulletin** ,1989 Nanomaterials Handbook Yury Gogotsi,2006-01-26 Even before it was identified as a science and given a name nanotechnology was the province of the most innovative inventors In medieval times craftsmen ingeniously employing nanometer sized gold particles created the enchanting red hues found in the gold ruby glass of cathedral windows Today nanomaterials are being just as creatively used to improve old products as well as usher in new ones From tires to CRTs to sunscreens nanomaterials are becoming a part of every industry The Nanomaterials Handbook provides a comprehensive overview of the current state of nanomaterials Employing terminology familiar to materials scientists and engineers it provides an introduction that delves into the unique nature of nanomaterials Looking at the quantum effects that come into play and other characteristics realized at the nano level it explains how the properties displayed by nanomaterials can differ from those displayed by single crystals and conventional microstructured monolithic or composite materials The introduction is followed by an in depth investigation of carbon based nanomaterials which are as important to nanotechnology as silicon is to electronics However it goes beyond the usual discussion of nanotubes and nanofibers to consider graphite whiskers cones and polyhedral crystals and nanocrystalline diamonds It also provides significant new information with regard to nanostructured semiconductors ceramics metals biomaterials and polymers as well as nanotechnology s application in drug delivery systems bioimplants and field emission displays The Nanomaterials Handbook is edited by world renowned nanomaterials scientist Yury Gogotsi who has recruited his fellow pioneers from academia national laboratories and industry to provide coverage of the latest material developments in America Asia Europe and Australia *Directory of Published Proceedings* ,2002 Additive Manufacturing of High-performance Metals and Alloys Igor Shishkovsky,2018-07-11 Freedoms in material choice based on combinatorial design different directions of process optimization and computational tools are a significant advantage of additive manufacturing technology The combination of additive and information technologies enables rapid prototyping and rapid manufacturing models on the design stage thereby significantly accelerating the design cycle in mechanical engineering Modern and high demand powder bed fusion and directed energy deposition methods allow obtaining functional complex shapes and functionally graded structures Until now the experimental parametric analysis remains as the main method during AM optimization Therefore an additional goal of this book is to introduce readers to new modeling and material s optimization approaches in the rapidly changing world of additive manufacturing of high performance metals and alloys EAI International Conference on Renewable Energy and Sustainable Manufacturing Nguyen Thanh Hai,Nguyen Xuan Huy,Khalil Amine,Tran Dai Lam,2024-10-17 This book presents the proceedings of the EAI International Conference on Renewable Energy and

Sustainable Manufacturing ICRESM 2023 which took place in Ho Chi Minh City Vietnam December 16 17 2023 The conference serves as a platform for researchers practitioners industry experts policymakers and stakeholders to share their latest findings innovations and best practices in the areas of sustainable practices and technologies that reduce reliance on non renewable resources and encourage the impacts of smart industry 4 0 The papers address global challenges relating to the sustainable manufacturing energy security and green technologies and discuss applications that aid in lowering carbon emissions preserving the environment and fostering economic growth by supporting renewable energy and eco friendly manufacturing Together the participants disseminate the latest technological advancements processes and strategies that promote renewable energy and sustainable manufacturing Advances in Nanotechnology Research and Application: 2012 Edition ,2012-12-26 Advances in Nanotechnology Research and Application 2012 Edition is a ScholarlyEditions eBook that delivers timely authoritative and comprehensive information about Nanotechnology The editors have built Advances in Nanotechnology Research and Application 2012 Edition on the vast information databases of ScholarlyNews You can expect the information about Nanotechnology in this eBook to be deeper than what you can access anywhere else as well as consistently reliable authoritative informed and relevant The content of Advances in Nanotechnology Research and Application 2012 Edition has been produced by the world s leading scientists engineers analysts research institutions and companies All of the content is from peer reviewed sources and all of it is written assembled and edited by the editors at ScholarlyEditions and available exclusively from us You now have a source you can cite with authority confidence and credibility More information is available at http www ScholarlyEditions com

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